Activity 6 Reading the Geologic History of Your Community

Goals

In this activity you will:

- Understand the basic principles used to determine the relative ages of rock units.
- Understand the nature and significance of unconformities and their role in deciphering geologic history.
- Interpret the geologic history of an area using the basic principles.

Think about It

Determining the ages of rock units relative to one another is, in a sense, similar to solving a puzzle.

- When you are studying rocks at an outcrop in your community, and you identify two different rock units, how can you tell which is older and which is younger?

What do you think? Record your ideas about this question in your *EarthComm* notebook. Include a quick sketch for each question. Be prepared to discuss your responses with your small group and the class.

Investigate

Part A: Basic Geologic Principles

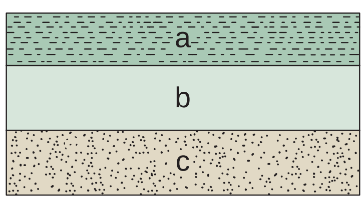
1. Roll out three different colors of soft, craft clay: red, yellow, and blue. Place the red layer flat on the table. Place the yellow layer on top of it, followed by the blue layer.

   a) Which layer is the "oldest" (i.e., has been there the longest)? Which layer is the "youngest"?

2. The geologic cross section in Figure A shows a series of layers of sedimentary units. As you learned in Activity 1, sedimentary rocks are laid down in layers, much like the layers of clay in step 1.

   a) Which of the units in the cross section do you think is the oldest? Which unit do you think is the youngest? How do you know?

Figure A



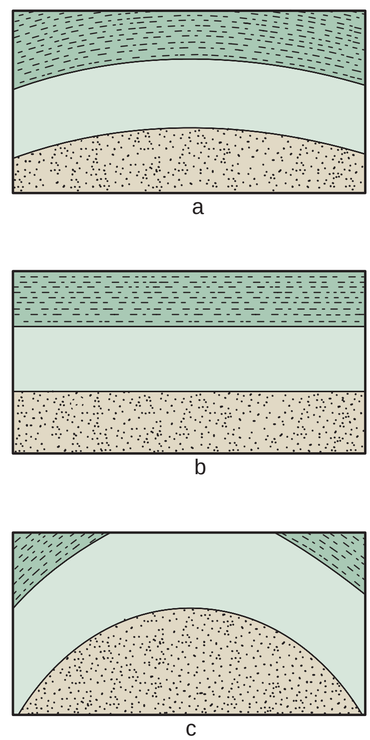
3. Take the clay layers from step 1.

   a) Sketch a side view of what you see.

   b) Now form the layers into folds, as you did in Activity 5. Sketch a side view of what you see.

   c) Sedimentary and igneous extrusive rocks are originally laid down in nearly horizontal layers. Why do you think that the layers are not horizontal? Number the cross sections in Figure B in the order in which they would occur.

Figure B

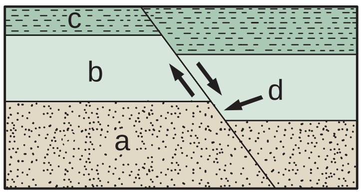


4. Flatten out the clay layers and again stack them into a block. Make a slanting cut through the block. Lift the lower side up relative to the upper side so that the red layer on the left matches up with the yellow layer on the right. Remember from Activity 5 that you have produced a normal fault.

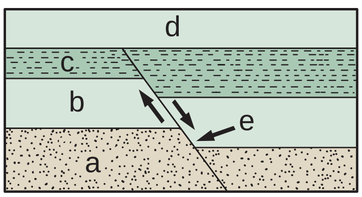
   a) Sketch what you see.

b) Now, look at the two cross sections shown in Figure C. What is the youngest feature in each of the two cross sections above? How do you know?

Figure C



a

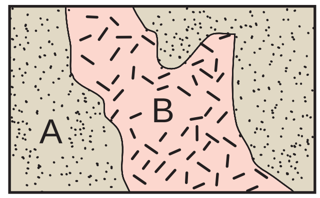


b

5. The following geologic cross section in Figure D shows a sedimentary rock unit A and an intrusive igneous rock unit B.

a) From what you know about how intrusive igneous rock units form, which of these units do you think is older? How do you know?

Figure D

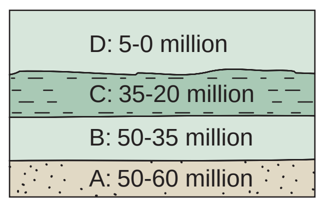


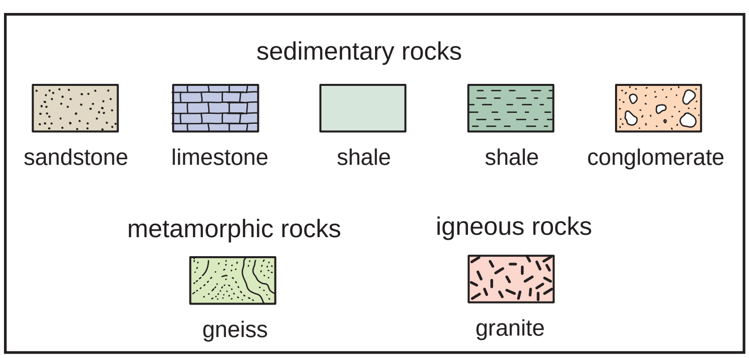
6. The rock units in the following cross section in Figure 6 have been assigned approximate age ranges.

a) Are the ages continuous, or do you see any time gaps?

b) Assume that these are sedimentary rocks that were formed as sediment was slowly deposited, layer upon layer. Can you think of an explanation for why there is a time gap in the record?

Figure E

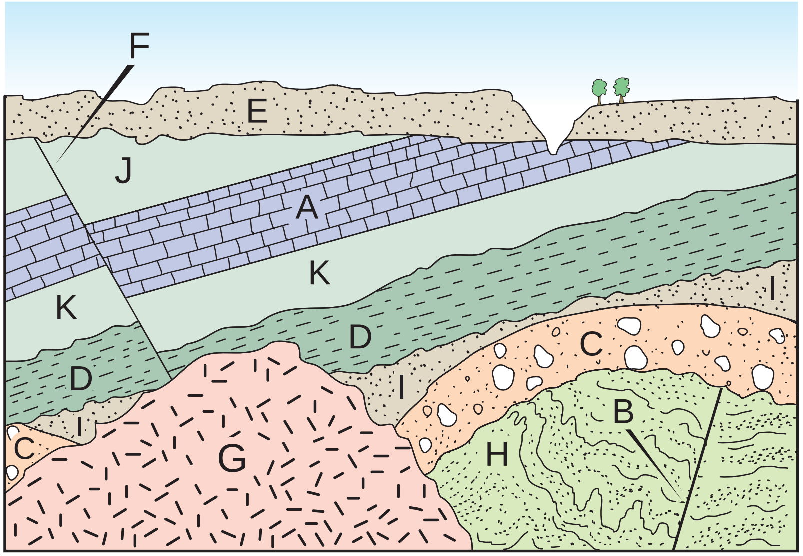




Part B: Using the Principles to Interpret Geologic History

1. The cross section shows several rock units in an area that has had a long and varied geologic history.

   a) Put the rock units and other geologic features marked with letters in the cross section in order of occurrence from earliest to latest. Start by asking yourself what was there first, and then work your way forward through time. You can think of this as a "geologic puzzle."



simplified cross section

Reflecting on the Activity and the Challenge

In this activity, you learned how geologists can use the relationships of rock units and geologic features such as folds or faults in order to interpret the geologic history of an area. You then applied basic principles to interpret the history of a geologically complex cross section. Being able to apply the basic principles of relative geologic time is essential to understanding the geologic history of your community and to helping you to complete the Chapter Challenge.

Digging Deeper

INTERPRETING GEOLOGIC HISTORY

Geologic Events and Processes

Most areas of the Earth's crust have had a long and often complex geologic history. Many kinds of geologic events can occur and many kinds of geologic processes can operate to shape the geologic history of an area. You have learned about many of these in previous activities. Here is a list of the most important ones: deposition, erosion, folding, faulting, uplift, subsidence, igneous intrusion, volcanism, and metamorphism.

The only processes in the list above that have not been mentioned up to now are **uplift** and **subsidence**. Local areas of the Earth's crust can be slowly raised (uplift) and lowered (subsidence) by large-scale forces acting within the Earth. Vertical changes in elevation can range from meters to kilometers. Much of uplift and subsidence is caused by the movement of the Earth's lithospheric plates, but it can also be caused just by changes in the temperature of the rocks. When rocks cool, they contract, and that causes subsidence. When rocks are heated, they expand, and that causes uplift. The degree of contraction and expansion is small, but because great thicknesses of rock are affected (kilometers to tens of kilometers), uplift and subsidence of the Earth's surface caused in this way can amount to hundreds of meters.

Basic Geologic Principles

You have learned that after geologists map an area of bedrock they usually construct one or more cross sections. They do that by projecting the rock units and other geologic features they see at the surface downward into the Earth. Once geologists have described the bedrock of the area by means of a map and one or more cross sections, they try to interpret the geologic history of the area. They do that by using several basic principles, which are listed below. Some of these principles might seem like just "common sense" to you, and in a way they are. When they were first developed long ago, however, they were revolutionary advances in how early geologists thought about the geologic record.

- **Principle of Superposition**: younger sedimentary and volcanic rocks are deposited on top of older rocks, as shown in *Figure 1*.
- **Principle of Original Horizontality**: sedimentary and volcanic rocks are laid down in approximately horizontal layers.
- **Principle of Lateral Continuity**: sedimentary and volcanic rocks are laid down in layers that are usually much greater in lateral extent than in thickness.

Geo Words

uplift: the process by which local areas of the Earth's crust can be slowly raised by large-scale forces acting within the Earth or the heating of rocks.

subsidence: the process by which local areas of the Earth's crust can be slowly lowered by large-scale forces acting within the Earth or the cooling of rocks.

Geo Words

unconformity: the contact between an earlier rock and younger sedimentary and/or volcanic layers.

- **Principle of Crosscutting Relationships**: if one rock unit or geologic feature cuts across another rock unit or geologic feature, it was formed later in geologic time. Here are two examples of this principle. If you see a rock unit cut by an igneous intrusion like a dike, you can be sure that the dike is younger than the rock unit. (See *Figure 2*.) If you see one or more rock units cut by a fault, you know that the fault is younger than the rock units. (See *Figure 3*.)

Unconformities

When you are trying to interpret the geologic history of an area, it is important to understand the concept of **unconformity**. All successions of sedimentary and volcanic rocks are deposited on some earlier rock surface. The contact between that earlier rock and the younger sedimentary and/or volcanic layers is called an unconformity. The significant thing about the unconformity is that for some period of geologic time, nothing except perhaps erosion was occurring on that surface. Some period of geologic time was not recorded at the unconformity. The "missing" time might be as short as thousands of years, but it is usually much longer: hundreds of thousands to many millions of years. At some unconformities, more than a billion years of Earth history is unrecorded!

Figure 1 In a series of rock layers, the oldest rocks are usually found on the bottom while the youngest rocks are on the top.

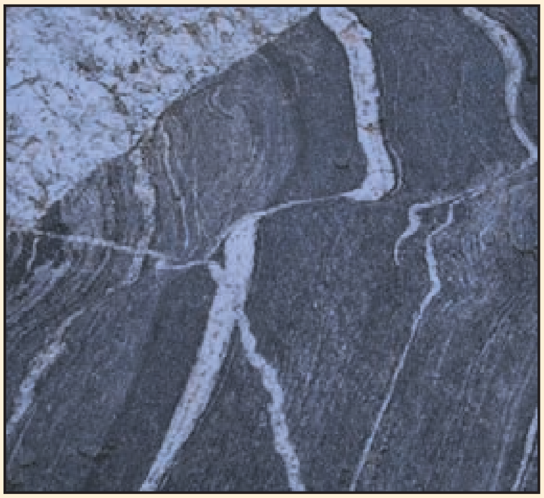


Figure 2 Which rock unit shown in the photograph is the youngest?

Figure 4 shows two common kinds of unconformity. In *Figure 4a*, a younger sedimentary succession is resting unconformably on an older sedimentary succession that was folded and then eroded down before conditions changed and more sediment was deposited. In *Figure 4b*, a younger sedimentary succession is resting unconformably on an intrusive body of granite. The granite was emplaced deep in the Earth, and then later erosion wore down the land surface to the level of the granite intrusion. Then conditions changed for some reason, and sediment was deposited on the previously eroded surface. You can see from these examples that recognizing an unconformity can be very helpful in interpreting geologic history.

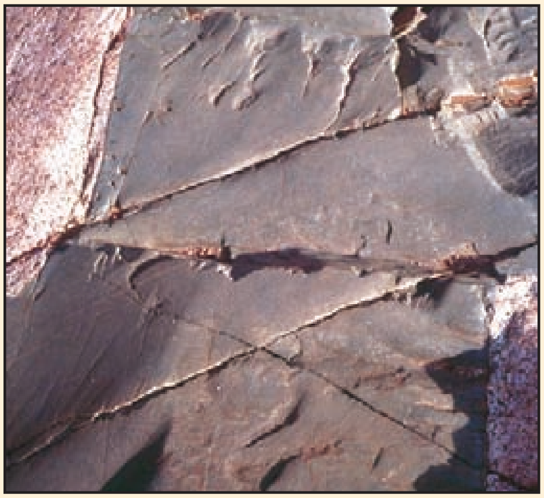


Figure 3 After intruding into the surrounding granite, this dike was offset by a fault.

Figure 4a An unconformity in which the older, underlying rocks are at a different angle than the younger, overlying rocks is called an angular unconformity.

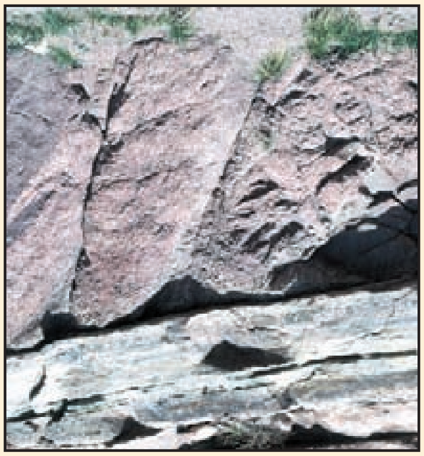


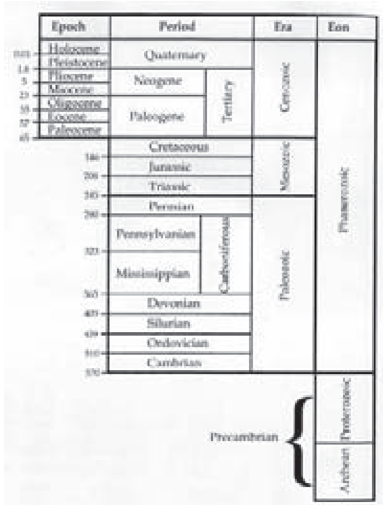
Figure 4b An unconformity developed when older igneous rocks were exposed to erosion before sedimentary rocks covered them is called a nonconformity.

Check Your Understanding

1. What causes uplift and subsidence?
2. How do unconformities form?
3. Define and explain two of the major principles used by geologists to interpret the rock record.

Understanding and Applying What You Have Learned

1. Can you think of a situation in which the Principle of Superposition does not work (i.e., when the oldest rocks are on top)?
2. Can the Principle of Original Horizontality be applied to metamorphic rocks? Why or why not?
3. Examine your state geologic map and geological cross sections.
   a) Which rock unit near your community is the oldest? Use the legend and the geologic time scale to estimate an age range for this rock.
   b) Which rock unit near your community is the youngest? Use the legend and the geologic time scale to estimate an age range for this rock.
   c) If there are any faults or folds in your area, when did they occur relative to the surrounding rocks?
   d) Is there evidence for any unconformities near your community? If so, use the legend and geologic time scale to estimate the length of time that is not recorded.



Preparing for the Chapter Challenge

Using the techniques that you have learned, prepare a chronological list (oldest to youngest) of geologic events that have occurred in your community. Be sure to include the order in which rocks formed, as well as when events like folding or faulting may have occurred. Remember to ask yourself the question: "What was there first?"

Inquiring Further

1. **Dating techniques**

   In this activity you have learned how to tell the relative age of rocks from their relationships to each other. Geologists also use other techniques to determine the ages of rocks. Research the following dating techniques and describe how they are used and how they differ from the technique that you learned in this activity:

   - Biostratigraphy
   - Radiometric dating